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# Improvement of a Questionnaire Measuring Activity Limitations in Rising and Sitting Down in Patients With Lower-Extremity Disorders Living at Home

Leo D. Roorda, MD, PT, Ivo W. Molenaar, PhD, Gustaaf J. Lankhorst, MD, PhD, Lex M. Bouter, PhD, and the Measuring Mobility Study Group

**ABSTRACT.** Roorda LD, Molenaar IW, Lankhorst GJ, Bouter LM, and the Measuring Mobility Study Group. Improvement of a questionnaire measuring activity limitations in rising and sitting down in patients with lower-extremity disorders living at home. *Arch Phys Med Rehabil* 2005;86:2204-10.

**Objective:** To improve a self-administered questionnaire that includes 42 dichotomous items and measures activity limitations in rising and sitting down (R&S) in patients with lower-extremity disorders who live at home.

**Design:** Cross-sectional study.

**Setting:** Outpatient clinics of secondary and tertiary care centers.

**Participants:** Patients (N=759; 47% men; mean age  $\pm$  standard deviation,  $60.7 \pm 15.2$ y) living at home, with lower-extremity disorders resulting from stroke, poliomyelitis, osteoarthritis, amputation, and complex regional pain syndrome type I.

**Interventions:** Not applicable.

**Main Outcome Measures:** (1) Unidimensionality, indicating that items assess only a single construct; (2) fit with the one-parameter logistic model (OPLM), yielding information about patient and item location parameters; (3) intratest reliability, indicating consistency of patients' item scores; and (4) content validity, indicating completeness with which the items cover the important aspects of the construct that they are attempting to represent.

**Results:** Thirty-nine of 42 items: (1) loaded on 1 component (variance explained, 59%; item component loadings,  $\geq .51$ ), (2) showed good fit with the OPLM ( $P=.15$ ), (3) had a good intratest reliability (Cronbach  $\alpha=.96$ ), and (4) had a good content validity (all important aspects represented).

**Conclusions:** A unidimensional scale that fits with the OPLM has been developed for measuring activity limitations in R&S in patients with lower-extremity disorders who live at home.

**Key Words:** Activities of daily living; Disability evaluation; Lower extremity; Psychometrics; Questionnaires; Rehabilitation.

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**T**HE ABILITY TO RISE and sit down (R&S) is important for maintaining mobility and independence. However, activity limitations in R&S are prevalent, especially in patients with lower-extremity disorders and in the elderly. In the non-institutionalized Dutch population, 7% of the general population and 36% of the elderly population (those  $\geq 85$ y) reported limitations in R&S.<sup>1</sup> Despite its importance, and the high prevalence of these limitations, little is known about the actual limitations in R&S as perceived by patients who live at home. Furthermore, the determinants of limitations in R&S are unclear,<sup>2</sup> and there is little indication of the severity of the activity limitations in specific statements about them. Most clinicians would agree that a positive response to a statement like "I use my arms when I get up from a low chair or sofa" indicates a minor limitation, whereas a positive response to a statement such as "I have difficulty getting onto a chair with a high seat" indicates a severe limitation. But what is indicated when a patient responds positively to a statement such as "It takes me longer to get up from the toilet"? A prerequisite in addressing these research questions is the availability of a suitable measurement instrument.

Most existing instruments do not provide a detailed measurement of activity limitations in R&S as perceived by patients living at home. Many generic<sup>3,4</sup> and disease-specific<sup>5-7</sup> measurement instruments provide a measurement of limitations perceived by such patients, but they do not provide a detailed measurement of limitations in R&S. However, some measurement instruments do provide such a measurement of limitations in R&S, but they usually result from a patient's timed performance on a test.<sup>8</sup> Studies of the relation between a patient's test-performance and self-reported perception of activity limitations at home have found only low-to-moderate correlations.<sup>9-11</sup> More recently, Stratford et al<sup>11</sup> questioned the content validity of timed performance tests.

Roorda et al<sup>12</sup> developed the Questionnaire Rising and Sitting Down (QR&S) to measure in detail R&S activity limitations as perceived by home-dwelling patients. Consisting of 32 items, it was tested in 345 patients with lower-extremity disorders. Results indicated that it could be seen as 2 unidimensional scales, positively correlated, each of which fit with a nonparametric item response theory (IRT) model (Mokken scale analysis).<sup>13</sup> The first scale addressed R&S from a high chair, a toilet or a bed, whereas the second scale addressed R&S from a low chair or a car. The reliability of the 2 scales was acceptable. The content validity of the questionnaire was safeguarded by including statements (items) addressing 3 dif-

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ferent aspects of limitations in R&S: velocity; use of arm(rest)s; and other adaptations.

Research methodologists often argue that rather than developing new measurement instruments, existing ones should be rigorously tested and improved, if necessary.<sup>14</sup> Rigorous testing includes confirming the instrument's quality in a second sample of patients. One improvement in the QR&S would be to create just 1 unidimensional scale. Another would be the fit with a more sophisticated parametric IRT model. Furthermore, the content validity of the QR&S might be improved by operationalizing, in addition to the 3 aforementioned aspects, a fourth aspect: difficulty in R&S. In several currently available measurement instruments, activity limitations are operationalized by asking questions about difficulty in performing certain activities.<sup>5,6</sup> Note that the term *operationalize* refers to the process of translating unobservable constructs—such as activity limitations as perceived by patients—into observable items.

Our purpose in this study was: (1) to simplify the dimensional structure of the QR&S; (2) to study the fit with a parametric IRT model; (3) to confirm its reliability; and (4) to extend the content to include the aspect of difficulty.

## METHODS

### Instrument

The self-administered instrument tested in this study contained 42 items—32 items from the first study of the QR&S<sup>12</sup> and 10 new items operationalizing difficulty in R&S. A summary of the instructions for the patients and the list of the 42 items that were tested are presented in appendix 1. Each item operationalizes the combination of (1) an activity limitation (rising, sitting down), (2) a certain aspect of this limitation (I, velocity; II, other adaptations; III, difficulty; IV, use of arm[rest]s) with respect to (3) a specific object (I, high chair; II, low chair; III, toilet; IV, bed; V, car seat). The aspects and objects were based on an extensive literature review.<sup>12</sup> The item “I have (some) difficulty getting up from the toilet,” for example, operationalizes the combination of (1) an activity limitation in rising, (2) the aspect of difficulty with respect to (3) the object toilet, whereas the item “I always hold on to something with both hands when I get into a car” operationalizes the combination of (1) an activity limitation in sitting down, (2) the aspect of use of arm(rest)s with respect to (3) the object car. Operationalizing the combination of (1) activity limitations in both R&S, (2) 4 aspects of limitations in R&S with respect to (3) 5 objects would result in 40 (2×4×5) items. Two items were dropped because of their low scalability coefficients in the first study.<sup>12</sup> A certain combination (limitations in sitting down, aspect of other adaptations, object car seat) was operationalized in 2 items (see appendix 1, items 28 and 29), resulting in an extra item. Finally, 3 extra items were added, operationalizing the aspect of use of arm(rest)s (see appendix 1, items 40 to 42). The resulting 42 (40+2+1+3) items tested are formulated in behavioral terms, and refer to what a patient actually does, and not to what he/she thinks they can do. Dichotomous items (response categories: YES box marked, YES box not marked) were used to facilitate interpretation.

### Participants

To test the measurement properties of the instrument, patients were recruited from several studies of home-dwelling subjects with lower-extremity disorders. First, patients with chronic stroke were sampled from a community-based cohort study<sup>15</sup> at the 2-year follow-up measurement. Second, patients with poliomyelitis were sampled from a cohort study,<sup>16</sup> also at

the 2-year follow-up measurement. Third, outpatients with hip or knee osteoarthritis (OA) who were undergoing arthroplasty were sampled from 2 general hospitals and 1 university hospital in an ongoing inception cohort study, directly after placement on the waiting list before surgery.<sup>17</sup> Fourth, outpatients with lower-extremity amputations who were undergoing multidisciplinary rehabilitation treatment were sampled from an ongoing inception cohort study at the end of their rehabilitation. In addition, consecutive eligible outpatient amputees were sampled from 2 orthopedic workshops. Fifth, patients with lower-extremity complex regional pain syndrome type I (CRPS I) who were participating in a randomized controlled trial were sampled from anesthesiology and surgical outpatient clinics of 2 university hospitals<sup>18</sup> at the first measurement. In addition, consecutive eligible patients with CRPS I<sup>19</sup> were sampled from the same departments. All patients completed the questionnaire and provided additional information about their age and sex.

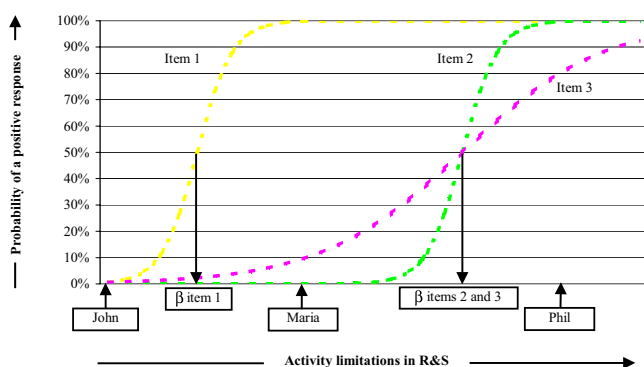
Seven hundred fifty-eight patients (359 men, 399 women) were enrolled in this study. Their mean age ± standard deviation was 60.7 ± 15.2 years. They had the following diagnoses: stroke (n=73)<sup>15</sup>; poliomyelitis (n=90)<sup>16</sup>; hip OA (n=211)<sup>17</sup>; knee OA (n=84); transfemoral or knee disarticulation amputation (n=102); transtibial amputation (n=105); other amputation (n=23); and CRPS I (n=70).<sup>18,19</sup> No response rates are available for the consecutive eligible outpatient amputees (n=169) and the consecutive eligible patients with CRPS I (n=29). The response rate (participants/participants eligible at the time of measurement) of the other participants was 92% (560/612), and for the different diagnostic groups: stroke 96% (73/76); poliomyelitis 87% (90/103); hip OA 89% (211/238); knee OA 91% (84/92); transfemoral or knee disarticulation amputation 100% (20/20); transtibial amputation 97% (34/35); other amputation 100% (7/7); and CRPS I 100% (41/41).

### Analysis

**Unidimensionality.** Unidimensionality indicates that the items assess only a single construct.<sup>20</sup> We explored it in this study with principal component analysis (PCA), followed by orthogonal (varimax) rotation. PCA was done with the tetrachoric correlations rather than the Pearson correlations between the items because tetrachoric correlations are more appropriate for dichotomous items.<sup>21</sup>

**Measurement with the one-parameter logistic model.** Measurement with an IRT model implies that information can be obtained about the activity limitations of each patient and about the characteristics of each item. Following is a brief introduction to the parametric IRT model one-parameter logistic model (OPLM)<sup>22,23</sup> that we used in this study. This model provides information about the item location and the item discrimination.

We will illustrate the concept of item location first with an example. Suppose that a questionnaire is completed by 3 patients: John with slight limitations in rising, Maria with moderate limitations, and Phil with severe limitations. The questionnaire in our simplified example consists of 2 items: item 1 addresses a difficult activity, such as rising from a low chair, whereas item 2 addresses an easy activity, such as rising from a high chair. John responds negatively to both items 1 and 2, because he has no problems with rising from either a low or a high chair. Maria responds positively to item 1, because she has problems with rising from a low chair, but she responds negatively to item 2, because she has no problems with rising from a high chair. Phil responds positively to both items, because he has problems with rising from both a low and a high chair. More in general, the relation between a patient's activity limitations and the possibility of responding positively to an item



**Fig 1.** Activity limitation parameters ( $\uparrow$ ) of John, Maria, and Phil, and IRFs (dotted lines) and item location parameters  $\beta_i$  ( $\downarrow$ ) of the items 1 to 3. Activity limitations in R&S on the x axis. Located more to the right on the x axis are patients with more activity limitations and items with higher item location parameters. Probability of a positive response on the y axis.

can be described by its item response function (IRF). Figure 1 shows the IRFs and the item locations of the items 1 and 2. This is the location on the x axis (fig 1) at which the probability of a positive response to the item at issue is 50%. Notice that item 2—which addresses an easy activity—is located more to the right on the x axis, and thus has a higher item location parameter than item 1.

In our example, the IRFs of the items 1 and 2 are parallel. In other words, these IRFs are shifted curves that do not intersect. Items with parallel IRFs will fit with the well-known Rasch model,<sup>24</sup> and can be characterized by their item location only. In many observed data sets however, including the one we studied, the IRFs are not parallel. That is, these IRFs cannot be seen as shifted curves and they can intersect each other. Figure 1 demonstrates IRFs that are not parallel (items 1 and 3; items 2 and 3). Items with nonparallel IRFs will not fit the Rasch model, but they may fit the OPLM. This is a more flexible model than the Rasch model because it can deal with IRFs that are not parallel, while maintaining the conceptual and technical advantages of the Rasch model. If the items fit the OPLM they can be characterized by their item location and item discrimination.

Next, we will illustrate the concept of item discrimination. Suppose that a third item is added to the questionnaire. Patients with activity limitations similar to those of Maria will respond negatively to item 2, whereas they can respond both positively (probability, 10%) and negatively (probability:  $100\% - 10\% = 90\%$ ) to item 3. Patients with activity limitations similar to those of Phil will respond positively to item 2, while they can respond both positively (probability, 80%) and negatively (probability:  $100\% - 80\% = 20\%$ ) to item 3. Figure 1 shows the nonparallel and intersecting IRFs of the items 2 and 3. The item discrimination is the slope of the IRF at the location at which the probability of a positive response to the item at issue is 50%. Notice that item 3—to which patients with activity limitations similar to those of Maria or Phil can respond both positively and negatively—has a less steep slope, and thus a lower discrimination, than item 2.

If the item set fits the OPLM, the activity limitations of each patient (with standard error [SE]), and the item location parameter  $\beta_i$  of each item (with SE) can be estimated. The responses of John, Maria, and Phil to the items yield information about their activity limitations and about the item locations. The patient's activity limitations and the item locations

are estimated independently on a common measurement continuum. Independent estimation generally means that the distribution of the activity limitations in the patient sample does not influence the estimation of the item locations. The patient's activity limitations and the item locations are expressed in log-odd units (logits). The logit is a unit of interval measurement that is defined within the context of the items.

If the item set fits the OPLM the item discriminations  $a_i$  of each item are imputed as known values.<sup>22,23</sup> It is a specific feature of the OPLM that the item discriminations  $a_i$  are not estimated from the data, but fixed at suitable integer values that may differ between items. These postulated values are assumed to be fixed during further calculations. In another IRT model, the 2-parameter logistic model (2PLM), the item discriminations are directly estimated from the data. The advantage of imputing item discriminations, and thus the advantage of the OPLM, is that the attractive mathematical properties of the Rasch model are combined with the flexibility of the 2PLM.<sup>22,23</sup> The disadvantage is that no information is obtained about the SEs of the item discrimination parameters.

**Fit with the OPLM.** The goodness-of-fit of an item set with the OPLM is investigated with 5 goodness-of-fit statistics: the  $S_i$  statistic, 3  $M_i$  statistics, and the  $R_{lc}$  statistic.<sup>22</sup> The  $S_i$  statistic and the 3  $M_i$  statistics are tests for the goodness-of-fit of the individual items with the OPLM, whereas the  $R_{lc}$  statistic is a global test for model fit of the whole item set. We report here only the  $S_i$  statistic because the conclusions drawn from the  $S_i$  and  $M_i$  statistics were similar in this study. The hypothesis that an item ( $S_i$  statistic) or an item set ( $R_{lc}$  statistic) shows good fit with the OPLM is rejected if its associated  $P$  value is smaller than or equal to .05.<sup>22</sup> The analyses were performed with the OPLM software program.<sup>22,a</sup>

**Intratest reliability.** The intratest reliability (or internal consistency) concerns the degree to which the patients' item scores are consistent.<sup>25</sup> The intratest reliability of the QR&S was quantified with the Cronbach  $\alpha$ . A reliability coefficient greater than or equal to .90 is recommended for decisions about individual patients.<sup>20</sup>

**Content validity.** Content validity refers to the completeness with which the items cover the important aspects of the construct that they attempt to represent.<sup>26</sup> In this study, the content of the questionnaire was safeguarded by a careful and transparent operationalization process (see Instrument section). Content validity was tested by counting the number of items in the final item set that operationalize (1) rising or sitting down, (2) each of the 4 aspects, and (3) each of the 5 objects.

## RESULTS

### Unidimensionality

The items predominantly loaded on 1 component. Three of the 42 items were removed from the scale because of their low discrimination parameters (see the Fit with the OPLM section below). The remaining 39 items also loaded on 1 component. With respect to those items, 6 components had eigenvalues greater than 1, and explained 59%, 6%, 5%, 4%, 3%, and 3%, respectively, of the variance. Because of these results we decided to choose the 1-component solution. The lowest item loading on this component was .52 (see table 1, item 31).

### Fit With the OPLM

All 42 items showed good fit or only a slight misfit with the OPLM, indicating that information could be obtained about the activity limitations of the patients, and the location and discrimination of the QR&S items. Three items were removed



**Table 1: Component Loadings, Mean Scores, Location Parameters With SE, Discrimination Parameters, and Goodness-of-Fit Statistics of the 39 QR&S Items Ordered by the Item Location Parameters**

Item*	PCA Loading <sup>†</sup>	OPLM						
		Mean <sup>‡</sup>	$\beta_i^{\S}$	SE( $\beta_i$ ) <sup>  </sup>	$a_i^{\P}$	$S_i^{\#}$	$df^{**}$	$P^{††}$
Car, S different way (36)	.59	.71	-.32	.02	4	4.47	7	.73
Car, R different way (17)	.60	.68	-.27	.02	4	4.08	7	.77
Bed, R arms (15)	.76	.73	-.26	.02	7	5.52	6	.48
Low chair, R arms (7)	.76	.71	-.23	.02	7	4.37	6	.63
Car, R longer (16)	.82	.70	-.21	.01	8	6.03	6	.42
Car, R (some) difficulty (18)	.76	.67	-.19	.01	7	5.78	6	.45
High chair, R arms (3)	.76	.65	-.16	.01	7	6.83	6	.34
Car, S longer (35)	.83	.64	-.14	.01	9	5.59	6	.47
Car, R hold on (19)	.72	.61	-.14	.02	6	14.23	7	<b>.05</b>
Low chair, R shift forward (5)	.74	.61	-.13	.02	6	7.03	7	.43
Low chair, R longer (4)	.80	.62	-.13	.01	8	2.63	6	.85
Bed, R shift to the edge (13)	.78	.60	-.12	.01	7	4.26	6	.64
Low chair, S arms (27)	.76	.59	-.10	.01	7	8.59	7	.28
Low chair, R (some) difficulty (6)	.78	.58	-.10	.01	7	9.13	7	.24
Car, S (some) difficulty (38)	.82	.58	-.09	.01	8	2.12	6	.91
Toilet, R hold on (11)	.76	.57	-.09	.01	7	7.09	7	.42
Toilet, S hold on (30)	.74	.52	-.04	.02	6	5.99	7	.54
Bed, S arms (34)	.72	.50	-.02	.02	6	4.62	7	.71
Car, S hold on (39)	.74	.50	-.02	.02	6	11.65	7	.11
Bed, R (some) difficulty (14)	.84	.47	-.02	.01	9	4.03	6	.67
Low chair, S (some) difficulty (26)	.81	.49	-.01	.01	8	5.61	7	.59
Bed, R longer (12)	.84	.46	.01	.01	9	2.32	6	.89
Low chair, S flop down (25)	.67	.47	.02	.02	5	6.67	7	.46
Low chair, S longer (24)	.84	.45	.02	.01	9	8.27	6	.22
High chair, S arms (23)	.72	.46	.03	.02	5	19.70	7	<b>.01</b>
Toilet, R longer (8)	.87	.43	.04	.01	11	3.44	5	.63
Toilet, R (some) difficulty (10)	.86	.41	.06	.01	9	8.12	6	.23
High chair, R longer (1)	.81	.38	.10	.01	8	2.29	6	.89
Toilet, S longer (28)	.86	.37	.10	.01	9	8.40	6	.21
Toilet, S (some) difficulty (29)	.86	.37	.10	.01	9	11.16	6	.08
High chair, R (some) difficulty (2)	.84	.35	.11	.01	9	6.63	6	.36
Car, S flop down (37)	.67	.35	.16	.02	5	7.66	7	.36
Bed, S (some) difficulty (33)	.86	.29	.18	.01	10	3.74	5	.59
Toilet, R shift forward (9)	.72	.30	.20	.02	6	12.30	7	.09
Bed, S longer (32)	.82	.24	.24	.01	9	4.62	5	.46
High chair, S longer (20)	.79	.23	.26	.02	8	15.39	5	<b>.01</b>
High chair, S flop down (21)	.67	.24	.27	.02	6	14.19	6	<b>.03</b>
High chair, S (some) difficulty (22)	.79	.21	.29	.02	8	16.76	5	<b>.01</b>
Bed, S "extra high" (31)	.52	.17	.59	.04	3	5.72	7	.57

Abbreviations: R, rising; S, sitting down.

\*The numbers in parentheses refer to the nonabbreviated items in appendix 1.

<sup>†</sup>Item component loading.<sup>‡</sup>Item mean score, indicating the proportion of participants responding positively to the item.<sup>§</sup>Item location parameter  $\beta_i$ . Higher scores indicate items with less positive responses.<sup>||</sup>SE of the item location parameter  $\beta_i$ .<sup>¶</sup>Item discrimination parameter  $a_i$ . Higher scores indicate more discriminating items.<sup>#</sup>Item goodness-of-fit statistic  $S_i$ .<sup>\*\*</sup>Degrees of freedom of the item goodness-of-fit statistic  $S_i$ .<sup>††</sup> $P$  of the item goodness-of-fit statistic  $S_i$ .  $P$  values of misfitting items ( $P \leq .05$ ) are in boldface.

from the scale (see appendix 1, items 40 to 42) because their discrimination was low, compared with the other 39 items. Moreover, these 3 items were the only items about being seated, whereas the other 39 items directly address limitations in R&S. The scaling characteristics of the remaining 39 items are summarized in table 1. The whole 39-item set showed good fit with the OPLM ( $P = .15$ ).

The item location parameters  $\beta_i$  for the items about sitting down were generally higher than for the items about rising in the 39-item set. This set contains 15 pairs of items that differ

only with respect to rising or sitting down, such as items 1 and 20. For 14 of these 15 pairs of items, the item about sitting down had a higher location parameter than the item about rising.

For the items about rising that are similarly phrased, the item location parameters  $\beta_i$  increase from car seat, via low chair, bed, and toilet to high chair in the 39-item set. For example, for the aspect of velocity in rising the item location parameters increase from car seat ( $\beta_i = -.21$ , item 16) via low chair ( $\beta_i = -.13$ , item 4), bed ( $\beta_i = .01$ , item 12), and toilet ( $\beta_i = .04$ ,

item 8) to high chair ( $\beta_i = .10$ , item 1). For the aspect of difficulty in rising ( $\beta_i = -.19$ , item 18;  $\beta_i = -.10$ , item 6;  $\beta_i = -.02$ , item 14;  $\beta_i = .06$ , item 10;  $\beta_i = .11$ , item 2) the same order is found.

With respect to sitting down, the order of the items is slightly different: the item location parameters  $\beta_i$  increase from car seat via low chair, toilet, and bed to high chair in the 39-item set. So the order of the items about the toilet and the bed is reversed. For example, for the aspect of velocity in sitting down the item location parameters increase from car seat ( $\beta_i = -.14$ , item 35) via low chair ( $\beta_i = .02$ , item 24), toilet ( $\beta_i = .10$ , item 28), and bed ( $\beta_i = .24$ , item 32) to high chair ( $\beta_i = .26$ , item 20). For the aspect of difficulty in sitting down the same (reversed) order of items is found.

There were marked differences (range, 3–11) in the discrimination parameters  $a_i$  of the items in the 39-item set. Furthermore, there seems to be an increase in the discrimination index from the operationalized aspect of adaptations in R&S (mean, 5.1; range, 3–7) via the aspect of use of arm(rest)s (mean, 6.4; range, 5–7) and the aspect of difficulty (mean, 8.4; range, 7–10), to the aspect of velocity (mean, 8.8; range, 8–10).

### Intratest Reliability

The intratest reliability of the 39-item set was good, even for decisions about individual patients,<sup>20</sup> because the Cronbach  $\alpha$  coefficient was .96.

### Content Validity

Rising and sitting down, and all the operationalized aspects and objects were covered well by the 39-item set. Nineteen items address rising (items 1 to 19), whereas 20 items address sitting down (items 20 to 39). Ten of the 39 items concern the aspect of velocity, 9 refer to other adaptations, 10 concern difficulty, and 10 are about the use of arm(rest)s. In addition, 7 of the 39 items are about a high chair, 8 are about a low chair, 7 are about a toilet, 8 are about a bed, and 9 are about a car seat.

## DISCUSSION

Our objective in this study was to improve a questionnaire originally developed to measure activity limitations in R&S in patients with lower-extremity disorders who live at home.<sup>12</sup> To test the instrument outpatients with different lower-extremity disorders were sampled. The disorders originated from different parts of the body: the brain (stroke), the peripheral nerve (poliomyelitis), the hip (OA), the upper leg (transfemoral amputation), the knee (OA, knee disarticulation amputation), the lower leg (transtibial amputation), and the foot (CRPS I, foot amputations).

Another objective for this study was to simplify the dimensional structure of the QR&S or, more specifically, to create a unidimensional scale. The 39-item set predominantly loaded on 1 component, indicating unidimensionality of the item set. In our first study of the QR&S,<sup>12</sup> we found 1 weak Mokken scale or 2 strong Mokken scales. Here, with a slightly different item set, a larger and somewhat different patient group, and a more sophisticated IRT model, a scale of 39 items was developed and there was little doubt about unidimensionality. We prefer the results of the current study and we recommend the use of this unidimensional scale.

Our next objective was to investigate the fit with a parametric IRT model: the OPLM. Fit with the OPLM was demonstrated for the 39-item set. The fact that none of the 39 items showed any important misfit with the OPLM may reflect the great flexibility of the OPLM, but may also be explained by the fact that the 39-item set used in this study contains 29 of the

32 items from our first study.<sup>12</sup> These 32 items were the “better” items from the original set of 54 items. Most of the (slightly) misfitting items (see table 1, items 20 to 22) were found at one end of the scale. Responding positively to these items is only an issue for a few patients. On the basis of their positive responses, the location and discrimination parameters of the items were assessed. Thus the misfit may be explained by not having obtained accurate estimates for these items.

The item location parameters  $\beta_i$  for the items about sitting down were higher than for the items about rising in the 39-item set, indicating that sitting down is an easier activity than rising. This finding agrees with clinical observations, and also confirms the results of Munton’s study,<sup>27</sup> and the findings from our first study.<sup>12</sup>

Furthermore, for the items about rising the item location parameters  $\beta_i$  increase in the 39-item set from car seat, via low chair, bed, and toilet to high chair. This implies that rising from a high chair is an easier activity than rising from a toilet, which is easier than rising from a bed, which is easier than rising from a low chair, which is easier than rising from a car seat, which is the least easy (or most difficult) of all the activities. We believe that this implication also agrees with clinical observations.

For the items about sitting down, the item location parameters  $\beta_i$  increase from car seat, via low chair, toilet, and bed to high chair in the 39-item set. Compared with the items about rising, the order of the items about the toilet and the bed is reversed. This means that rising from the toilet is an easier activity than rising from the bed, whereas sitting down on the toilet is less easy (or more difficult) than sitting down on the bed. This may reflect the fact that toilets have harder surfaces than beds, which makes it easier to rise from the toilet, whereas sitting down is more difficult because a hard surface requires a careful “landing.”

There were marked differences in the item discrimination parameters  $a_i$  in the 39-item set. The item discriminations seem to increase from the operationalized aspect of adaptations in R&S, via the aspect of use of arm(rest)s and the aspect of difficulty, to the aspect of velocity. We are unaware of any possible explanation for this phenomenon.

Another purpose of our study was to confirm the reliability of the QR&S. The intratest reliability of the new single scale of 39 items (intratest reliability coefficient, .96) was better than the intratest reliability of the 2 original scales<sup>12</sup> (intratest reliability coefficients, .77 and .91, respectively). We did not investigate test-retest reliability in this study. However, our first study,<sup>12</sup> and a study by Perez et al.,<sup>19</sup> demonstrated a satisfactory test-retest reliability of the 2 original global scales of the QR&S. These 2 original global scales include 29 of the current 39 items, so it is reasonable to expect satisfactory test-retest reliability of the new single global scale. Nevertheless, this expectation must be confirmed through further research.

The final purpose of this study was to extend the content of the QR&S to include the aspect of difficulty in R&S was done without any problems. Other possible aspects of limitations in R&S—not included in the 39-item set of the QR&S—might be the use of aids or the use of help. Operationalizations of these 2 aspects were used in our first study. Based on the results of that study, the items operationalizing both aspects were dropped from the item set, because of the low proportion of patients responding positively to them. These items were therefore irrelevant for most patients. We think that this reflects the fact that the instrument was developed for and tested in patients living at home, and not institutionalized patients.

Future research should test other clinimetric properties of the QR&S. We recently demonstrated in a similar patient group that the items in the Climbing Stairs Questionnaire<sup>28</sup> had satisfactory clinimetric properties in the total group of patients, but there were some differences within different diagnostic subgroups of patients (robustness), and more marked differences in item characteristics (differential item functioning [DIF]) between these subgroups. This should be considered when comparisons are made between these different diagnostic subgroups of patients. So, the robustness and the DIF of the QR&S should be tested in further research.

In summary, testing the quality of the QR&S yielded satisfactory results, and the QR&S can be recommended as a measurement instrument for clinical research. For some applications in daily clinical practice, however, the complete instrument may be too detailed. In such cases one could use just part of the instrument only. First, one could use a subset of items. An important property of IRT models—including the OPLM—is that the measurement of patients is generally “test-free.”<sup>24</sup> This means that using different subsets of the items will result, after simple rescaling, in approximately the same estimate of the patient’s activity limitations. For example, one could use the subset of items operationalizing the aspect of velocity that are the most discriminative. The total number of items included in the subset could be based on the desired precision of the measurement. Second, one could use the items 36, 17, 15, and 7 (see table 1) for quick screening. It is very unlikely that patients who respond negatively to these four items will have limitations in R&S. It is unlikely that patients who claim that they do not have any problems in rising from a car seat or a low chair will have activity limitations in R&S with respect to high chairs, beds, or toilets. In our opinion, this knowledge can be applied in daily clinical practice in rehabilitation medicine. The clinician could ask the patient whether he/she has any problems getting out of a car or rising from a low chair. If the patient’s response is positive, the clinician should then address this topic in more detail, and attempt to assess the severity of the activity limitation. If the patient’s response is negative, the clinician should—after this quick screening—address other possible activity limitations, for instance, limitations in walking or climbing stairs.

## CONCLUSIONS

A unidimensional scale fitting with the OPLM has been developed for the measurement of limitations in rising and sitting down in patients with different lower-extremity disorders who live at home.

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## APPENDIX 1: SUMMARY OF THE INSTRUCTIONS FOR THE PATIENTS AND THE 42 TESTED QR&S ITEMS

Please answer YES to every statement that **both** applies to your current situation and is connected with your health.

1. It takes me longer to get up from a chair with a high seat, eg, from a dining chair, a kitchen chair, or an office chair.
2. I have (some) difficulty getting up from a chair with a high seat.
3. I always use my arms when I get up from a chair with a high seat, eg, I hold on to the table to pull myself up, I push myself up with the armrests, or I push myself off the seat.
4. It takes me longer to get up from a low chair or sofa, eg, from an easy chair or a deep sofa.
5. I always have to shift forward a little at first before I get up from a low chair or sofa.
6. I have (some) difficulty getting up from a low chair or sofa.
7. I always use my arms when I get up from a low chair or sofa, eg, I hold on to the table to pull myself up, I push myself up with the armrests, or I push myself off the seat.
8. It takes me longer to get up from the toilet.
9. I always shift forward a little at first before I get up from the toilet.
10. I have (some) difficulty getting up from the toilet.
11. I always hold on to something to get up from the toilet, eg, the door post, the wash basin, a handle, or an arm support.
12. It takes me longer to get up from the bed.
13. I always shift to the edge of the bed at first before I get up from the bed.
14. I have (some) difficulty getting up from the bed.
15. I always use my arms when I get up from the bed, eg, I hold on to something or I push myself up from the bed with my hands.
16. It takes me longer to get out of a car.
17. I get out of a car but I do that in a different way, eg, I first put both my legs on the ground and then I stand up.
18. I have (some) difficulty getting out of a car.
19. I always hold on to something with both hands when I get out of a car.
20. It takes me longer to get onto a chair with a high seat, eg, onto a dining chair, a kitchen chair, or an office chair.
21. When I sit down on a chair with a high seat, I always flop down at the end.
22. I have (some) difficulty getting onto a chair with a high seat.
23. I always use my arms when I get onto a chair with a high seat, eg, I hold on to the table, I lean on the armrests, or I lean on the seat.
24. It takes me longer to sit down on a low chair or sofa, eg, on an easy chair or a deep sofa.
25. When I sit down on a low chair or sofa I always flop down at the end.
26. I have (some) difficulty sitting down on a low chair or sofa.
27. I always use my arms when I sit down on a low chair or sofa, eg, I hold on to the table, I lean on the armrests, or I lean on the seat.
28. It takes me longer to sit down on the toilet.
29. I have (some) difficulty sitting down on the toilet.

30. I always hold on to something when I sit down on the toilet, eg, the door post, the wash basin, a handle, or an arm support.
31. I only sit down on an "extra high" bed, and not on an ordinary bed.
32. It takes me longer to sit down on the bed.
33. I have (some) difficulty sitting down on the bed.
34. I always use my arms when I sit down on the bed, eg, I hold on to something, or I lean on the bed with my hands.
35. It takes me longer to get into a car.
36. I get into a car but I do that in a different way, eg, I first sit down and then I pull my legs inside.
37. When I get into a car I always flop down at the end.
38. I have (some) difficulty getting into a car.
39. I always hold on to something with both hands when I get into a car.
40. I only sit on a high-seated chair that has armrests and not on a high-seated chair without armrests.
41. I only sit on a low chair or sofa that has armrests and not on a low chair or sofa without armrests.
42. I only use toilets that have arm supports and not toilets with no arm supports.

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